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Ada COMPILER
VALIDATION SUMMARY REPORT:
Certificate Number: 880627W1.09093
Concurrent Computer Corporation
$C^3$Ada, R02-00.00
Concurrent Computer Corporation 3280 MPS

Completion of On-Site Testing:
30 June 1988

Prepared By:
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ASD/SCEL
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Prepared For:
Ada Joint Program Office
United States Department of Defense
Washington DC 20301-3081

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C3 Ada, R02-00.00, Concurrent Computer Corporation, Wright-Patterson Air Force Base, Concurrent Computer Corporation 3280 MPS under OS/32, Version R08-02.02 (Host and (Target), ACVC 1.9.

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Testing Completed 30 June 1988 Using ACVC 1.9

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# CHAPTER 1

# INTRODUCTION

This Validation Summary Report (VSR) describes the extent to which a specific Ada compiler conforms to the Ada Standard, ANSI/MIL-STD-1815A. This report explains all technical terms used within it and thoroughly reports the results of testing this compiler using the Ada Compiler Validation Capability (ACVC). An Ada compiler must be implemented according to the Ada Standard, and any implementation-dependent features must conform to the requirements of the Ada Standard. The Ada Standard must be implemented in its entirety, and nothing can be implemented that is not in the Standard.

Even though all validated Ada compilers conform to the Ada Standard, it must be understood that some differences do exist between implementations. The Ada Standard permits some implementation dependencies--for example, the maximum length of identifiers or the maximum values of integer types. Other differences between compilers result from the characteristics of particular operating systems, hardware, or implementation strategies. All the dependencies observed during the process of testing this compiler are given in this report.

The information in this report is derived from the test results produced during validation testing. The validation process includes submitting a suite of standardized tests, the ACVC, as inputs to an Ada compiler and evaluating the results. The purpose of validating is to ensure conformity of the compiler to the Ada Standard by testing that the compiler properly implements legal language constructs and that it identifies and rejects illegal language constructs. The testing also identifies behavior that is implementation dependent but permitted by the Ada Standard. Six classes of tests are used. These tests are designed to perform checks at compile time, at link time, and during execution.

## INTRODUCTION

### 1.1 PURPOSE OF THIS VALIDATION SUMMARY REPORT

This VSR documents the results of the validation testing performed on an Ada compiler. Testing was carried out for the following purposes:

- To attempt to identify any language constructs supported by the compiler that do not conform to the Ada Standard
- To attempt to identify any language constructs not supported by the compiler but required by the Ada Standard
- To determine that the implementation-dependent behavior is allowed by the Ada Standard

Testing of this compiler was conducted by SofTech, Inc. under the direction of the AVF according to procedures established by the Ada Joint Program Office and administered by the Ada Validation Organization (AVO). On-site testing was completed 30 June 1988 at Tinton Falls NJ.

### 1.2 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the AVO may make full and free public disclosure of this report. In the United States, this is provided in accordance with the "Freedom of Information Act" (5 U.S.C. #552). The results of this validation apply only to the computers, operating systems, and compiler versions identified in this report.

The organizations represented on the signature page of this report do not represent or warrant that all statements set forth in this report are accurate and complete, or that the subject compiler has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from:

Ada Information Clearinghouse
Ada Joint Program Office
OUSDRE
The Pentagon, Rm 3D-139 (Fern Street)
Washington DC 20301-3081

or from:

Ada Validation Facility
ASD/SCEL
Wright-Patterson AFB OH 45433-6503

Questions regarding this report or the validation test results should be directed to the AVF listed above or to:

Ada Validation Organization
Institute for Defense Analyses
1801 North Beauregard Street
Alexandria VA 22311

## 1.3 REFERENCES

1. Reference Manual for the Ada Programming Language, ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.

2. Ada Compiler Validation Procedures and Guidelines, Ada Joint Program Office, 1 January 1987.

3. Ada Compiler Validation Capability Implementers' Guide, SofTech, Inc., December 1986.

4. Ada Compiler Validation Capability User's Guide, December 1986.

## 1.4 DEFINITION OF TERMS

| | |
|---|---|
| ACVC | The Ada Compiler Validation Capability. The set of Ada programs that tests the conformity of an Ada compiler to the Ada programming language. |
| Ada Commentary | An Ada Commentary contains all information relevant to the point addressed by a comment on the Ada Standard. These comments are given a unique identification number having the form AI-ddddd. |
| Ada Standard | ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987. |
| Applicant | The agency requesting validation. |
| AVF | The Ada Validation Facility. The AVF is responsible for conducting compiler validations according to procedures contained in the Ada Compiler Validation Procedures and Guidelines. |
| AVO | The Ada Validation Organization. The AVO has oversight authority over all AVF practices for the purpose of maintaining a uniform process for validation of Ada compilers. The AVO provides administrative and technical |

support for Ada validations to ensure consistent practices.

Compiler — A processor for the Ada language. In the context of this report, a compiler is any language processor, including cross-compilers, translators, and interpreters.

Failed test — An ACVC test for which the compiler generates a result that demonstrates nonconformity to the Ada Standard.

Host — The computer on which the compiler resides.

Inapplicable test — An ACVC test that uses features of the language that a compiler is not required to support or may legitimately support in a way other than the one expected by the test.

Passed test — An ACVC test for which a compiler generates the expected result.

Target — The computer for which a compiler generates code.

Test — A program that checks a compiler's conformity regarding a particular feature or a combination of features to the Ada Standard. In the context of this report, the term is used to designate a single test, which may comprise one or more files.

Withdrawn test — An ACVC test found to be incorrect and not used to check conformity to the Ada Standard. A test may be incorrect because it has an invalid test objective, fails to meet its test objective, or contains illegal or erroneous use of the language.

## 1.5 ACVC TEST CLASSES

Conformity to the Ada Standard is measured using the ACVC. The ACVC contains both legal and illegal Ada programs structured into six test classes: A, B, C, D, E, and L. The first letter of a test name identifies the class to which it belongs. Class A, C, D, and E tests are executable, and special program units are used to report their results during execution. Class B tests are expected to produce compilation errors. Class L tests are expected to produce compilation or link errors.

Class A tests check that legal Ada programs can be successfully compiled and executed. There are no explicit program components in a Class A test to check semantics. For example, a Class A test checks that reserved words of another language (other than those already reserved in the Ada language) are not treated as reserved words by an Ada compiler. A Class A test is passed if no errors are detected at compile time and the program executes to produce a PASSED message.

Class B tests check that a compiler detects illegal language usage. Class B tests are not executable. Each test in this class is compiled and the resulting compilation listing is examined to verify that every syntax or semantic error in the test is detected. A Class B test is passed if every illegal construct that it contains is detected by the compiler.

Class C tests check that legal Ada programs can be correctly compiled and executed. Each Class C test is self-checking and produces a PASSED, FAILED, or NOT APPLICABLE message indicating the result when it is executed.

Class D tests check the compilation and execution capacities of a compiler. Since there are no capacity requirements placed on a compiler by the Ada Standard for some parameters--for example, the number of identifiers permitted in a compilation or the number of units in a library--a compiler may refuse to compile a Class D test and still be a conforming compiler. Therefore, if a Class D test fails to compile because the capacity of the compiler is exceeded, the test is classified as inapplicable. If a Class D test compiles successfully, it is self-checking and produces a PASSED or FAILED message during execution.

Each Class E test is self-checking and produces a NOT APPLICABLE, PASSED, or FAILED message when it is compiled and executed. However, the Ada Standard permits an implementation to reject programs containing some features addressed by Class E tests during compilation. Therefore, a Class E test is passed by a compiler if it is compiled successfully and executes to produce a PASSED message, or if it is rejected by the compiler for an allowable reason.

Class L tests check that incomplete or illegal Ada programs involving multiple, separately compiled units are detected and not allowed to execute. Class L tests are compiled separately and execution is attempted. A Class L test passes if it is rejected at link time--that is, an attempt to execute the main program must generate an error message before any declarations in the main program or any units referenced by the main program are elaborated.

Two library units, the package REPORT and the procedure CHECK_FILE, support the self-checking features of the executable tests. The package REPORT provides the mechanism by which executable tests report PASSED, FAILED, or NOT APPLICABLE results. It also provides a set of identity functions used to defeat some compiler optimizations allowed by the Ada Standard that would circumvent a test objective. The procedure CHECK_FILE is used to check the contents of text files written by some of the Class C tests for chapter 14 of the Ada Standard. The operation of REPORT and CHECK_FILE is checked by a set of executable tests. These tests produce messages that are examined to verify that the units are operating correctly. If these units are not operating correctly, then the validation is not attempted.

The text of the tests in the ACVC follow conventions that are intended to ensure that the tests are reasonably portable without modification. For example, the tests make use of only the basic set of 55 characters, contain lines with a maximum length of 72 characters, use small numeric values, and

place features that may not be supported by all implementations in separate tests. However, some tests contain values that require the test to be customized according to implementation-specific values--for example, an illegal file name. A list of the values used for this validation is provided in Appendix C.

A compiler must correctly process each of the tests in the suite and demonstrate conformity to the Ada Standard by either meeting the pass criteria given for the test or by showing that the test is inapplicable to the implementation. The applicability of a test to an implementation is considered each time the implementation is validated. A test that is inapplicable for one validation is not necessarily inapplicable for a subsequent validation. Any test that was determined to contain an illegal language construct or an erroneous language construct is withdrawn from the ACVC and, therefore, is not used in testing a compiler. The tests withdrawn at the time of this validation are given in Appendix D.

# CHAPTER 2

# CONFIGURATION INFORMATION

## 2.1 CONFIGURATION TESTED

The candidate compilation system for this validation was tested under the following configuration:

Compiler: $C^3$ Ada, R02-00.00

ACVC Version: 1.9

Certificate Number: 880627W1.09093

Host Computer:

| | |
|---|---|
| Machine: | Concurrent Computer Corporation 3280 MPS |
| Operating System: | OS/32 Version R08-02.02 |
| Memory Size: | 16 megabytes |

Target Computer:

| | |
|---|---|
| Machine: | Concurrent Computer Corporation 3280 MPS |
| Operating System: | OS/32 Version R08-02.02 |
| Memory Size: | 16 megabytes |

## 2.2 IMPLEMENTATION CHARACTERISTICS

One of the purposes of validating compilers is to determine the behavior of a compiler in those areas of the Ada Standard that permit implementations to differ. Class D and E tests specifically check for such implementation differences. However, tests in other classes also characterize an implementation. The tests demonstrate the following characteristics:

- Capacities.

  The compiler correctly processes tests containing loop statements nested to 65 levels, block statements nested to 65 levels, and recursive procedures separately compiled as subunits nested to 17 levels. It correctly processes a compilation containing 723 variables in the same declarative part. (See tests D55A03A..H (8 tests), D56001B, D64005E..G (3 tests), and D29002K.)

- Universal integer calculations.

  An implementation is allowed to reject universal integer calculations having values that exceed SYSTEM.MAX_INT. This implementation processes 64 bit integer calculations. (See tests D4A002A, D4A002B, D4A004A, and D4A004B.)

- Predefined types.

  This implementation supports the additional predefined types SHORT_INTEGER, LONG_FLOAT, and TINY_INTEGER in the package STANDARD. (See tests B86001C and B86001D.)

- Based literals.

  An implementation is allowed to reject a based literal with a value exceeding SYSTEM.MAX_INT during compilation, or it may raise NUMERIC_ERROR or CONSTRAINT_ERROR during execution. This implementation raises NUMERIC_ERROR during execution. (See test E24101A.)

- Expression evaluation.

  Apparently no default initialization expressions for record components are evaluated before any value is checked to belong to a component's subtype. (See test C32117A.)

  Assignments for subtypes are performed with the same precision as the base type. (See test C35712B.)

This implementation uses no extra bits for extra precision. This implementation uses all extra bits for extra range. (See test C35903A.)

Sometimes NUMERIC_ERROR is raised when an integer literal operand in a comparison or membership test is outside the range of the base type. (See test C45232A.)

Apparently NUMERIC_ERROR is raised when a literal operand in a fixed-point comparison or membership test is outside the range of the base type. (See test C45252A.)

Apparently underflow is not gradual. (See tests C45524A..Z.)

- Rounding.

  The method used for rounding to integer is apparently round away from zero. (See tests C46012A..Z.)

  The method used for rounding to longest integer is apparently round away from zero. (See tests C46012A..Z.)

  The method used for rounding to integer in static universal real expressions is apparently round away from zero. (See test C4A014A.)

- Array types.

  An implementation is allowed to raise NUMERIC_ERROR or CONSTRAINT_ERROR for an array having a 'LENGTH that exceeds STANDARD.INTEGER'LAST and/or SYSTEM.MAX_INT. For this implementation:

  Declaration of an array type or subtype declaration with more than SYSTEM.MAX_INT components raises no exception. (See test C36003A.)

  NUMERIC_ERROR is raised when 'LENGTH is applied to an array type with INTEGER'LAST + 2 components. (See test C36202A.)

  NUMERIC_ERROR is raised when 'LENGTH is applied to an array type with SYSTEM.MAX_INT + 2 components. (See test C36202B.)

  A packed BOOLEAN array having a 'LENGTH exceeding INTEGER'LAST raises NUMERIC_ERROR when the array type is declared. (See test C52103X.)

  A packed two-dimensional BOOLEAN array with more than INTEGER'LAST components raises CONSTRAINT_ERROR when declaring array subtypes. (See test C52104Y.)

A null array with one dimension of length greater than INTEGER'LAST may raise NUMERIC_ERROR or CONSTRAINT_ERROR either when declared or assigned. Alternatively, an implementation may accept the declaration. However, lengths must match in array slice assignments. This implementation raises NUMERIC_ERROR when the array type is declared. (See test E52103Y.)

In assigning one-dimensional array types, the expression appears to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. In assigning two-dimensional array types, the expression does not appear to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

- Discriminated types.

  During compilation, an implementation is allowed to either accept or reject an incomplete type with discriminants that is used in an access type definition with a compatible discriminant constraint. This implementation accepts such subtype indications. (See test E38104A.)

  In assigning record types with discriminants, the expression appears to be evaluated in its entirety before CONSTRAINT_ERROR is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

- Aggregates.

  In the evaluation of a multi-dimensional aggregate, all choices appear to be evaluated before checking against the index type. (See tests C43207A and C43207B.)

  In the evaluation of an aggregate containing subaggregates, all choices are evaluated before being checked for identical bounds. (See test E43212B.)

  All choices are evaluated before CONSTRAINT_ERROR is raised if a bound in a nonnull range of a nonnull aggregate does not belong to an index subtype. (See test E43211B.)

- Representation clauses for this implementation.

  An implementation might legitimately place restrictions on representation clauses used by some of the tests. If a representation clause is used by a test in a way that violates a restriction, then the implementation must reject it.

Enumeration representation clauses containing noncontiguous values for enumeration types other than character and boolean types are supported. (See tests C35502I..J, C35502M..N, and A39005F.)

Enumeration representation clauses containing noncontiguous values for character types are supported. (See tests C35507I..J, C35507M..N, and C55B16A.)

Enumeration representation clauses for boolean types containing representational values other than (FALSE => 0, TRUE => 1) are supported. (See tests C35508I..J and C35508M..N.)

Length clauses with SIZE specifications for enumeration types are supported. (See test A39005B.)

Length clauses with STORAGE_SIZE specifications for access types are supported. (See tests A39005C and C87B62B.)

Length clauses with STORAGE_SIZE specifications for task types are not supported. (See tests A39005D and C87B62D.)

Length clauses with SMALL specifications are supported. (See tests A39005E and C87B62C.)

Record representation clauses are not supported. (See test A39005G.)

Length clauses with SIZE specifications for derived integer types are supported. (See test C87B62A.)

- Pragmas.

  The pragma INLINE is supported for procedures and functions. (See tests LA3004A, LA3004B, EA3004C, EA3004D, CA3004E, and CA3004F.)

- Input/output.

  The package SEQUENTIAL_IO can be instantiated with unconstrained array types and record types with discriminants without defaults. (See tests AE2101C, EE2201D, and EE2201E.)

  The package DIRECT_IO can be instantiated with unconstrained array types and record types with discriminants without defaults. (See tests AE2101H and EE2401G.)

  Modes IN_FILE and OUT_FILE are supported for SEQUENTIAL_IO. (See tests CE2102D and CE2102E.)

  Modes IN_FILE, OUT_FILE, and INOUT_FILE are supported for DIRECT_IO. (See tests CE2102F, CE2102I, and CE2102J.)

RESET and DELETE are supported for SEQUENTIAL_IO and DIRECT_IO. (See tests CE2102G and CE2102K.)

Dynamic creation and deletion of files are supported for SEQUENTIAL_IO and DIRECT_IO. (See tests CE2106A and CE2106B.)

Overwriting to a sequential file does not truncate the file. (See test CE2208B.)

An existing text file can be opened in OUT_FILE mode, can be created in OUT_FILE mode, and can be created in IN_FILE mode. (See test EE3102C.)

More than one internal file can be associated with each external file for text I/O for both reading and writing. (See tests CE3111A..E (5 tests), CE3114B, and CE3115A.)

More than one internal file can be associated with each external file for sequential I/O for both reading and writing, except when the external file is a temporary file. (See tests CE2107A..D (4 tests), CE2110B, and CE2111D.)

More than one internal file can be associated with each external file for direct I/O for both reading and writing, except when the external file is a temporary file. (See tests CE2107F..I (5 tests), CE2110B, and CE2111H.)

An internal sequential access file and an internal direct access file can be associated with a single external file for writing. (See test CE2107E.)

An external file associated with more than one internal file cannot be deleted for SEQUENTIAL_IO, DIRECT_IO, and TEXT_IO. (See test CE2110B.)

Temporary sequential and direct files are not supported. (See tests CE2108A and CE2108C.)

- Generics.

Generic subprogram declarations and bodies can be compiled in separate compilations. (See tests CA1012A and CA2009F.)

Generic package declarations and bodies can be compiled in separate compilations. (See tests CA2009C, BC3204C, and BC3205D.)

Generic unit bodies and their subunits can be compiled in separate compilations. (See test CA3011A.)

# CHAPTER 3

# TEST INFORMATION

## 3.1 TEST RESULTS

Version 1.9 of the ACVC comprises 3122 tests. When this compiler was tested, 27 tests had been withdrawn because of test errors. The AVF determined that 252 tests were inapplicable to this implementation. All inapplicable tests were processed during validation testing except for 201 executable tests that use floating-point precision exceeding that supported by the implementation. Modifications to the code, processing, or grading for 4 tests were required to successfully demonstrate the test objective. (See section 3.6.)

The AVF concludes that the testing results demonstrate acceptable conformity to the Ada Standard.

## 3.2 SUMMARY OF TEST RESULTS BY CLASS

| RESULT | TEST CLASS | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | L | |
| Passed | 108 | 1049 | 1606 | 17 | 17 | 46 | 2843 |
| Inapplicable | 2 | 2 | 247 | 0 | 1 | 0 | 252 |
| Withdrawn | 3 | 2 | 21 | 0 | 1 | 0 | 27 |
| TOTAL | 113 | 1053 | 1874 | 17 | 19 | 46 | 3122 |

## 3.3 SUMMARY OF TEST RESULTS BY CHAPTER

| RESULT | CHAPTER | | | | | | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| Passed | 182 | 498 | 537 | 245 | 166 | 98 | 141 | 326 | 137 | 36 | 234 | 3 | 240 | 2843 |
| Inapplicable | 22 | 74 | 137 | 3 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 13 | 252 |
| Withdrawn | 2 | 14 | 3 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 2 | 1 | 2 | 27 |
| TOTAL | 206 | 586 | 677 | 248 | 166 | 99 | 145 | 327 | 137 | 36 | 236 | 4 | 255 | 3122 |

## 3.4 WITHDRAWN TESTS

The following 27 tests were withdrawn from ACVC Version 1.9 at the time of this validation:

| | | | | |
|---|---|---|---|---|
| B28003A | C35904B | C37215E | C45332A | CC1311B |
| E28005C | C35A03E | C37215G | BC3105A | A35902C |
| C34004A | C35A03R | C37215H | A74106C | AD1A01A |
| C35502P | C37213H | C38102C | C85018B | CE2401H |
| C35904A | C37213J | C41402A | C87B04B | CE3208A |
| C37215C | C45614C | | | |

See Appendix D for the reason that each of these tests was withdrawn.

## 3.5 INAPPLICABLE TESTS

Some tests do not apply to all compilers because they make use of features that a compiler is not required by the Ada Standard to support. Others may depend on the result of another test that is either inapplicable or withdrawn. The applicability of a test to an implementation is considered each time a validation is attempted. A test that is inapplicable for one validation attempt is not necessarily inapplicable for a subsequent attempt. For this validation attempt, 252 tests were inapplicable for the reasons indicated:

- C24113D..K (8 tests) have line lengths greater than $MAX_IN_LEN.
- C35702A uses SHORT_FLOAT which is not supported by this implementation.

- A39005D and C87B62D use length clauses with STORAGE_SIZE specifications for task types which are not supported by this implementation.

- A39005G uses a record representation clause which is not supported by this compiler.

- The following tests use LONG_INTEGER, which is not supported by this compiler:

| | | | | |
|---|---|---|---|---|
| C45231C | C45304C | C45502C | C45503C | C45504C |
| C45504F | C45611C | C45613C | C45631C | C45632C |
| B52004D | C55B07A | B55B09C | | |

- C45304B, C45504B, and C45632B have been ruled inapplicable by the AVO because intermediate results may be out of range, but the final result is not. According to LRM 11.6, an implementation need not raise a NUMERIC_ERROR or CONSTRAINT_ERROR in such a case.

- C45531M, C45531N, C45532M, and C45532N use fine 48-bit fixed-point base types which are not supported by this compiler.

- C45531O, C45531P, C45532O, and C45532P use coarse 48-bit fixed-point base types which are not supported by this compiler.

- C86001F redefines package SYSTEM, but TEXT_IO is made obsolete by this new definition in this implementation and the test cannot be executed since the package REPORT is dependent on the package TEXT_IO.

- C96005B requires the range of type DURATION to be different from those of its base type; in this implementation they are the same.

- CE2107C..D (2 tests), CE2107H..I (2 tests), CE2108A..D (4 tests) CE3112A..B (2 tests), and CE3114B are inapplicable because temporary files are not supported.

- EE2401D is inapplicable because this implementation does not support DIRECT_IO with unconstrained array types. This implementation raises USE_ERROR on CREATE.

- CE3111B requires that one (internal) file be able to read a value that was just written by another file that shares the same external file; but this implementation raises END_ERROR, since the value is not actually written from the buffer to the external file until a NEW_LINE, RESET, or CLOSE operation is performed. The AVO ruled that this is acceptable behavior.

- The following 201 tests require a floating-point accuracy that exceeds the maximum of 15 digits supported by this implementation:

| | |
|---|---|
| C24113L..Y (14 tests) | C35705L..Y (14 tests) |
| C35706L..Y (14 tests) | C35707L..Y (14 tests) |

| | |
|---|---|
| C35708L..Y (14 tests) | C35802L..Z (15 tests) |
| C45241L..Y (14 tests) | C45321L..Y (14 tests) |
| C45421L..Y (14 tests) | C45521L..Z (15 tests) |
| C45524L..Z (15 tests) | C45621L..Z (15 tests) |
| C45641L..Y (14 tests) | C46012L..Z (15 tests) |

## 3.6 TEST, PROCESSING, AND EVALUATION MODIFICATIONS

It is expected that some tests will require modifications of code, processing, or evaluation in order to compensate for legitimate implementation behavior. Modifications are made by the AVF in cases where legitimate implementation behavior prevents the successful completion of an (otherwise) applicable test. Examples of such modifications include: adding a length clause to alter the default size of a collection; splitting a Class B test into subtests so that all errors are detected; and confirming that messages produced by an executable test demonstrate conforming behavior that wasn't anticipated by the test (such as raising one exception instead of another).

Modifications were required for four Class B tests.

The following Class B tests were split because syntax errors at one point resulted in the compiler not detecting other errors in the test:

BC2001D BC2001E BC3205B BC3205D

## 3.7 ADDITIONAL TESTING INFORMATION

### 3.7.1 Prevalidation

Prior to validation, a set of test results for ACVC Version 1.9 produced by the $C^3$Ada R02-00.00 compiler was submitted to the AVF by the applicant for review. Analysis of these results demonstrated that the compiler successfully passed all applicable tests, and the compiler exhibited the expected behavior on all inapplicable tests.

### 3.7.2 Test Method

Testing of the $C^3$ Ada R02-00.00 compiler using ACVC Version 1.9 was conducted on-site by a validation team from the AVF. The configuration consisted of a Concurrent Computer Corporation 3280 MPS operating under OS/32, R08-02.02.

A magnetic tape containing all tests except for withdrawn tests and tests requiring unsupported floating-point precisions was taken on-site by the validation team for processing. Tests requiring modifications during the prevalidation testing were included in their modified form on the magnetic tape.

The contents of the magnetic tape were loaded directly onto the host computer. After the test files were loaded to disk, the full set of tests was compiled on the Concurrent Computer Corporation 3280 MPS, and all executable tests were linked and run. Results were printed directly from the computer.

The compiler was tested using command scripts provided by Concurrent Computer Corporation and reviewed by the validation team. The compiler was tested using all default option settings except for the following:

LIST — The LIST option controls the generation of the source listing from the compiler. A listing of all source lines is generated.

OPTIMIZE — This option controls the action of performing simple optimizations like constant folding, dead code elimination, and peephole optimization.

PAGE_SIZE — This option specifies the number of significant lines per page on the listing file. The default is 60 lines per page.

SEGMENTED — This option specifies that the code generated is to be segmented in PURE and IMPURE code.

Tests were compiled, linked, and executed (as appropriate) using a single host computer. Test output, compilation listings, and job logs were captured on magnetic tape and archived at the AVF. The listings examined on-site by the validation team were also archived.

### 3.7.3 Test Site

Testing was conducted at Tinton Falls NJ and was completed on 30 June 1988.

# APPENDIX A

## DECLARATION OF CONFORMANCE

Concurrent Computer Corporation has submitted the following Declaration of Conformance concerning the $C^3$ Ada R02-00.00 compiler.

## DECLARATION OF CONFORMANCE

**Compiler Implementor:** Concurrent Computer Corporation
**Ada Validation Facility:** ASD/SCEL, Wright-Patterson AFB, OH
**Ada Compiler Validation Capability (ACVC) Version:** 1.9

### Base Configuration

**Base Compiler Name:** C $^3$Ada **Version:** R02-00.00

**Base Host Architecture ISA:** Concurrent Computer Corporation 3280 MPS
(Under OS/32, Version R08-02.02)
**Base Target Architecture ISA:** Concurrent Computer Corporation 3280 MPS
(Under OS/32, Version R08-02.02)

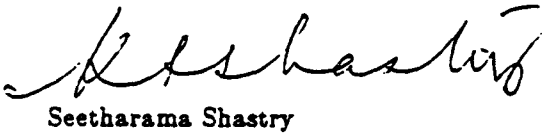
### Derived Configuration

**Derived Compiler Name:** C $^3$Ada **Version:** R02-00.00

**Derived Host Architecture ISA:** Concurrent Computer Corporation Series 3200
3200MPS, 3203, 3205, 3210, 3230, 3250,
3230XP, 3250XP, 3230MPS, 3260MPS.
(Under OS/32, Version R08-02.02)
**Derived Target Architecture ISA:** All Hosts, Self Targeted
(Under OS/32, Version R08-02.02)

### Implementor's Declaration

I, the Undersigned, representing Concurrent Computer Corporation have implemented no deliberate extensions to the Ada Language Standard ANSI/MIL-STD-1815A in the compilers listed in this declaration. I declare that Concurrent Computer Corporation is the owner of record of the Ada language compilers listed above and, as such, is responsible for maintaining the said compilers in conformance to ANIS/MIL-STD-1815A. All certificates and registrations for Ada language compiler(s) listed in this declaration shall be made only in the owner's corporate name.



6/28/88

Seetharama Shastry
Manager, System Software Development (Date)

## Owner's Declaration

I, the undersigned, representing Concurrent Computer Corporation take full responsibility for implementation and maintenance of the Ada Compilers listed above, and agree to public disclosure of the final Validation Summary Report. I further agree to continue to comply with the Ada trademark policy, as defined by the Ada Joint Program Office. I declare that all of the Ada language compilers listed, and their host/target performance are in compliance with the Ada Language Standard ANSI/MIL-STD-1815A.

S Shastry 6/28/88

Seetharama Shastry
Manager, System Software Development (Date)

# APPENDIX B

## APPENDIX F OF THE Ada STANDARD

The only allowed implementation dependencies correspond to implementation-dependent pragmas, to certain machine-dependent conventions as mentioned in chapter 13 of the Ada Standard, and to certain allowed restrictions on representation clauses. The implementation-dependent characteristics of the C Ada, R02-00.00, are described in the following sections, which discuss topics in Appendix F of the Ada Standard. Implementation-specific portions of the package STANDARD are also included in this appendix.

```
package STANDARD is

     ...

     type INTEGER is range -2147483648 .. 2147483647;
     type TINY_INTEGER is range -128 .. 127;
     type SHORT_INTEGER is range -32768 .. 32767;

     type FLOAT is digits 6 range -1.93428E+25 .. 1.93428E+25;
     type LONG_FLOAT is digits 15
            range -2.57110087081438E+61 .. 2.57110087081438E+61;

     type DURATION is delta 2#1.0#E-14
          range -131072.00 .. 131071.99993896484375;

     ...

end STANDARD;
```

# APPENDIX F
# IMPLEMENTATION-DEPENDENT CHARACTERISTICS

## F.1 INTRODUCTION

The following sections provide all implementation-dependent characteristics of the C$^3$Ada Compiler.

## F.2 IMPLEMENTATION-DEPENDENT PRAGMAS

The following is the syntax representation of a pragma:

```
pragma IDENTIFIER [(ARGUMENT [,ARGUMENT])];
```

**Where:**

| | |
|---|---|
| *IDENTIFIER* | is the name of the pragma. |
| *ARGUMENT* | defines a parameter of the pragma. For example, the LIST pragma expects the arguments ON or OFF. |

Table F-1 summarizes all of the recognized pragmas and whether they are implemented or not.

**TABLE F-1. SUMMARY OF RECOGNIZED PRAGMAS**

| PRAGMA | IMPLEMENTED | COMMENTS |
|---|---|---|
| BIT_PACK | Yes | This pragma allows packing of composite non-FLOAT type objects to the bit level, thereby achieving greater data compaction. Use of this pragma will result in longer compile and run times. |
| CONTROLLED | No | Automatic storage reclamation of unreferenced access objects is not applicable to the C$^3$Ada implementation. |
| ELABORATE | Yes | Is handled as defined by the Ada language. |
| INLINE | Yes | Subprogram bodies are expanded inline at each call. |
| INTERFACE | Yes | Is implemented for ASSEMBLER and FORTRAN. |
| LIST | Yes | Is handled as defined by the Ada language. |
| MEMORY_SIZE | No | The user cannot specify the number of available storage units in the machine configuration which is defined in package SYSTEM. |
| OPTIMIZE | No | The user cannot specify either time or space as the primary optimization criterion. |
| PACK | Yes | The elements of an array or record are packed down to a minimal number of bytes. |
| PAGE | Yes | Is handled as defined by the Ada language. |
| PARTIAL_IMAGE | Yes | This pragma informs the compiler that the named package may be used to build a partial image, and causes the compiler to verify that the package meets all requirements for such use. |
| PRIORITY | No | The task or main_program cannot have priority. |
| SHARED | No | Not applicable because every read or update of the variable declared by an object declaration and whose type is a scalar or access type is a synchronization point for that variable. |

TABLE F-1. SUMMARY OF RECOGNIZED PRAGMAS (Continued)

| PRAGMA | IMPLEMENTED | COMMENTS |
|---|---|---|
| STACK_CHECK | Yes | When specified with the argument OFF, this pragma indicates to the compiler that there is enough space in the initial stack chunk for the activation record of all subroutines that may be active at any time. Therefore, no code is generated which checks for providing additional space for the run-time stack of any task or of the main task. This pragma may appear wherever the use of a pragma is legal. |
| STORAGE_UNIT | No | The user cannot specify the number of bits per storage unit, which is defined in package SYSTEM. |
| SUPPRESS | No | All run-time checks, such as ACCESS_CHECK, INDEX_CHECK, RANGE_CHECK, etc., cannot be suppressed for any specific type, object, subprogram etc., See the description of SUPPRESS_ALL. |
| SUPPRESS_ALL | Yes | This pragma gives the compiler permission to omit all of the following run-time checks for all types and objects in the designated compilation units: ACCESS_CHECK, RANGE_CHECK, LENGTH_CHECK, INDEX_CHECK, DISCRIMINANT_CHECK and OVERFLOW_CHECK for all integer and fixed point calculations. The pragma must be placed before each compilation unit. |
| SYSTEM_NAME | No | The user cannot specify the target system name, which is defined in package SYSTEM. |

### F.2.1 Pragma INLINE Restrictions

Inline expansion of a subprogram call will not occur if the following conditions are not satisfied:

1. If the subprogram body is contained in the same compilation unit as the call, the complete text of the body must precede the call. If the subprogram body is not contained in the same compilation unit as the call, the compilation unit containing the body must be compiled before the unit containing the call. (Care should be taken that the unit containing the body is not recompiled, since this would make the unit containing the call obsolete.) For every call of a subprogram for which pragma INLINE is given, a warning message is reported if the subprogram body is not already known to the compiler as indicated above; the warning message indicates that inline expansion is not done for that particular call.
2. The subprogram body and any enclosed declare blocks may not contain:

   - declarations of subprograms
   - declarations of task types or single tasks
   - body stubs
   - generic instaniations

   For every call of a subprogram for which pragma INLINE is given, a warning message is reported if this set of conditions is not satisfied; the message indicates that inline expansion is not done for that particular call.
3. The subprogram body, excluding any enclosed declare blocks, may not contain

   - declarations of objects with task subcomponents
   - declarations of access types where the designated type has task subcomponents
   - exception handlers

   For every call of a subprogram for which pragma INLINE is given, a warning message is reported if this set of conditions is not satisfied; the message indicates that inline expansion is not done for that particular call.
4. Inline expansion occurs when the expanded code contains a valid subprogram call. However, a duplicate inline expansion is not carried out for a subprogram call if inline

expansion for that subprogram is already in process (e.g., a recursive call). A warning message is generated informing the user that this is the case.

## F.3 LENGTH CLAUSES

A length clause specifies the amount of storage associated with a given type. The following is a list of the implementation-dependent attributes.

| | |
|---|---|
| T'SIZE | must be a multiple of eight. Must be 32 for a type derived from FLOAT, and 64 for a type derived from LONG_FLOAT. For array and record types, only the size chosen by the compiler may be specified. |
| T'STORAGE_SIZE | is fully supported for collection size specification. |
| T'STORAGE_SIZE | is not supported for task activation. Task memory is limited by the work space for the program. |
| T'SMALL | must be a power of two for a fixed point type. |

Size representation only applies to types - not to subtypes. In the following example, the size of T is 32, but the size of T1 is not necessarily 32.

```
type T is integer range  0..100;
subtype T1 is T range 0..10;
for T'SIZE use 32;
```

In the following example, the size of the subtype is the same as the size of the type (size of the type is applied to the subtype).

```
type T is integer range  0..100;
for T'SIZE use 32;
subtype T2 is T range 0..10;
```

## F.4 REPRESENTATION ATTRIBUTES

The Representation attributes listed below are as described in the *Reference Manual for the Ada Programming Language*, Section 13.7.2.

X'ADDRESS

**NOTE**

Attribute ADDRESS is not supported for labels. Package SYSTEM must be named by a with clause of a compilation unit if the predefined attribute ADDRESS is used within that unit.

X'SIZE

R.C'POSITION

R.C'FIRST_BIT

R.C'LAST_BIT

| | |
|---|---|
| T'STORAGE_SIZE | for access types, returns the current amount of storage reserved for the type. If a T'STORAGE_SIZE representation clause has been specified, then the amount specified is returned. Otherwise the current amount allocated is returned. |
| T'STORAGE_SIZE | for task types or objects is not implemented. It returns 0. |

## F.4.1 Representation Attributes of Real Types

P'DIGITS — yields the number of decimal digits for the subtype P. This value is six for type FLOAT, and 15 for type LONG_FLOAT.

P'MANTISSA — yields the number of binary digits in the mantissa of P. The value is 21 for type FLOAT, and 51 for type LONG_FLOAT.

| DIGITS | MANTISSA | DIGITS | MANTISSA | DIGITS | MANTISSA |
|---|---|---|---|---|---|
| 1 | 5 | 6 | 21 | 11 | 38 |
| 2 | 8 | 7 | 25 | 12 | 41 |
| 3 | 11 | 8 | 28 | 13 | 45 |
| 4 | 15 | 9 | 31 | 14 | 48 |
| 5 | 18 | 10 | 35 | 15 | 51 |

P'EMAX — yields the largest exponent value of model numbers for the subtype P. The value is 84 for type FLOAT, and 204 for type LONG_FLOAT.

| DIGITS | EMAX | DIGITS | EMAX | DIGITS | EMAX |
|---|---|---|---|---|---|
| 1 | 20 | 6 | 84 | 11 | 152 |
| 2 | 32 | 7 | 100 | 12 | 164 |
| 3 | 44 | 8 | 112 | 13 | 180 |
| 4 | 60 | 9 | 124 | 14 | 192 |
| 5 | 72 | 10 | 140 | 15 | 204 |

P'EPSILON — yields the absolute value of the difference between the model number 1.0 and the next model number above for the subtype P. The value is 16#0.00001# for type FLOAT, and 16#0.0000_0000_0000_4# for type LONG_FLOAT.

| DIGITS | EPSILON | DIGITS | EPSILON | DIGITS | EPSILON |
|---|---|---|---|---|---|
| 1 | 16#0.1#E00 | 6 | 16#0.1#E-4 | 11 | 16#0.8#E-9 |
| 2 | 16#0.2#E-1 | 7 | 16#0.1#E-5 | 12 | 16#0.1#E-9 |
| 3 | 16#0.4#E-2 | 8 | 16#0.2#E-6 | 13 | 16#0.1#E-10 |
| 4 | 16#0.4#E-3 | 9 | 16#0.4#E-7 | 14 | 16#0.2#E-11 |
| 5 | 16#0.8#E-4 | 10 | 16#0.4#E-8 | 15 | 16#0.4#E-12 |

P'SMALL — yields the smallest positive model number of the subtype P. The value is 16#0.8#E-21 for type FLOAT, and 16#0.8#E-51 for type LONG_FLOAT.

| VALUES | SMALL | VALUES | SMALL | VALUES | SMALL |
|---|---|---|---|---|---|
| 1 | 16#0.8#E-5 | 6 | 16#0.8#E-21 | 11 | 16#0.8#E-38 |
| 2 | 16#0.8#E-8 | 7 | 16#0.8#E-25 | 12 | 16#0.8#E-41 |
| 3 | 16#0.8#E-11 | 8 | 16#0.8#E-28 | 13 | 16#0.8#E-45 |
| 4 | 16#0.8#E-15 | 9 | 16#0.8#E-31 | 14 | 16#0.8#E-48 |
| 5 | 16#0.8#E-18 | 10 | 16#0.8#E-35 | 15 | 16#0.8#E-51 |

P'LARGE — yields the largest positive model number of the subtype P. The value is 16#0.FFFFFF8#E21 for type FLOAT, and 16#0.FFFF_FFFF_FFFF_E#E51 for type LONG_FLOAT.

| VALUES | LARGE |
|---|---|
| 1 | 16#0.F8#E5 |
| 2 | 16#0.FF#E8 |
| 3 | 16#0.FFE#E11 |
| 4 | 16#0.FFFE#E15 |
| 5 | 16#0.FFFF_C#E18 |
| 6 | 16#0.FFFF_F8#E21 |
| 7 | 16#0.FFFF_FF8#E25 |
| 8 | 16#0.FFFF_FFF#E28 |
| 9 | 16#0.FFFF_FFFE#E31 |
| 10 | 16#0.FFFF_FFFF_E#E35 |
| 11 | 16#0.FFFF_FFFF_FC#E38 |
| 12 | 16#0.FFFF_FFFF_FF8#E41 |
| 13 | 16#0.FFFF_FFFF_FFF8#E45 |
| 14 | 16#0.FFFF_FFFF_FFFF#E48 |
| 15 | 16#0.FFFF_FFFF_FFFF_E#E51 |

P'SAFE_EMAX — yields the largest exponent value of safe numbers of type P. The value is 252 for types FLOAT and LONG_FLOAT.

P'SAFE_SMALL — yields the smallest positive safe number of type P. The value is 16#0.8#E-63 for types FLOAT and LONG_FLOAT.

P'SAFE_LARGE — yields the largest positive safe number of the type P. The value is 16#0.FFFF_F8#E63 for type FLOAT, and 16#0.FFFF_FFFF_FFFF_FE#E63 for type LONG_FLOAT.

P'RANGE — yields the range -16#0.FFFF_FF#E63 .. 16#0.FFFF_FF#E63 for type FLOAT, and -16#0.FFFF_FFFF_FFFF_FF#E63 .. 16#0.FFFF_FFFF_FFFF_FF#E63 for type LONG_FLOAT.

P'MACHINE_ROUNDS — is true.

P'MACHINE_OVERFLOWS — is true.

P'MACHINE_RADIX — is 16.

P'MACHINE_MANTISSA — is six for types derived from FLOAT; else 14.

P'MACHINE_EMAX — is 63.

P'MACHINE_EMIN — is -64.

### F.4.2 Representation Attributes of Fixed Point Types

For any fixed point type T, the representation attributes are:

T'MACHINE_ROUNDS — true

T'MACHINE_OVERFLOWS — true

### F.4.3 Enumeration Representation Clauses

The maximum number of elements in an enumeration type is limited by the maximum size of the enumeration image table which cannot be greater than 65535 bytes. The enumeration table size is determined by the following function:

```
generic
   type ENUMERATION_TYPE is (<>);
function ENUMERATION_TABLE_SIZE return NATURAL is
   RESULT : NATURAL :=0;
begin
   for I in ENUMERATION_TYPE 'FIRST..ENUMERATION_TYPE' LAST loop
      RESULT :=RESULT + 2 + I'WIDTH;
   end loop;
   return RESULT;
end ENUMERATION_TABLE_SIZE;
```

### F.4.4 Record Representation Clauses

The *Reference Manual for the Ada Programming Language* states that an implementation may generate names that denote implementation-dependent components. This is not present in this release of the C³Ada Compiler.

RESTRICTIONS - Floating point types must be fullword-aligned, that is, placed at a storage position that is a multiple of 32.

Record components of a private type cannot be included in a record representation specification.

Record clause alignment can only be 1, 2 or 4.

Component representations for access types must allow for at least 24 bits.

Component representations for scalar types other than for types derived from LONG_FLOAT must not specify more than 32 bits.

### F.4.5 Type Duration

Duration'small equals 61.03515625 microseconds or $2^{-14}$ seconds. This number is the smallest power of two which can still represent the number of seconds in a day in a fullword fixed point number.

System.tick equals 10ms. The actual computer clock-tick is 1.0/120.0 seconds (or about 8.33333ms) in 60HZ areas and 1.0/100.0 seconds (or 10ms) in 50HZ areas. System.tick represents the greater of the actual clock-tick from both areas.

Duration'small is significantly smaller than the actual computer clock-tick. Therefore, the least amount of delay possible is limited by the actual clock-tick. The delay of duration'small follows this formula:

<actual-clock-tick> ± <actual-clock-tick> + 4.45ms

The 4.45ms represents the overhead or the minimum delay possible on a Model 3250 or 3200MPS Family of Processors. For 60HZ areas, the range of delay is approximately from 4.45ms to 21.11666ms. For 50HZ areas, the range of delay is approximately from 4.45ms to 24.45ms. However, on the average, the delay is slightly greater than the actual clock-tick.

In general, the formula for finding the range of a delay value, *x*, is:

nearest_multiple(x,<actual-clock-tick>) ± <actual-clock-tick> + 4.45ms

where nearest_multiple rounds *x* up to the nearest multiple of the actual clock-tick.

**TABLE F-2. TYPE DURATION**

| | | |
|---|---|---|
| DURATION'DELTA | 2#1.0#E-14 | ≃ 61μs |
| DURATION'SMALL | 2#1.0#E-14 | ≃ 61μs |
| DURATION'FIRST | -131072.00 | ≃ 36 hrs |
| DURATION'LAST | 131071.99993896484375 | ≃ 36 hrs |
| DURATION'SIZE | 32 | |

## F.5 ADDRESS CLAUSES

Address clauses are implemented for objects. No storage is allocated for objects with address clauses by the compiler. The user must guarantee the storage for these by some other means (e.g., through the use of the absolute instruction found in the *Common Assembly Language/32 (CAL/32) Reference Manual*). The exception PROGRAM_ERROR is raised upon reference to the object if the specified address is not in the program's address space or is not properly aligned.

RESTRICTIONS - Address clauses are not implemented for subprograms, packages or task units. In addition, address clauses are not available for use with task entries (i.e., interrupts).

Initialization of an object that has an address clause specified is not supported. Objects with address clauses may also be used to map objects into global task common (TCOM) areas. See Chapter 4 for more information regarding task common.

## F.6 THE PACKAGE SYSTEM

The package SYSTEM, provided with the C³Ada system permits access to machine-dependent features. The specification of the package SYSTEM declares constant values dependent on the Series 3200 Processors. The following is a listing of the visible section of the package SYSTEM specification.

```
package SYSTEM is

   type ADDRESS is private;

   type NAME is (CCUR_3200);

   SYSTEM_NAME   : constant NAME := CCUR_3200;
   STORAGE_UNIT  : constant := 8;
   MEMORY_SIZE   : constant := 2 ** 24;
   MIN_INT       : constant := - 2_147_483_648;
   MAX_INT       : constant := 2_147_483_647;
   MAX_DIGITS    : constant := 15;
   MAX_MANTISSA  : constant := 31;
   FINE_DELTA    : constant := 2#1.0#E-30;
   TICK          : constant := 0.01;

   type UNSIGNED_SHORT_INTEGER is range 0 .. 65_535;

   type UNSIGNED_TINY_INTEGER is range 0 .. 255;

   for UNSIGNED_SHORT_INTEGER'SIZE use 16;

   for UNSIGNED_TINY_INTEGER'SIZE use 8;

   subtype PRIORITY      is INTEGER range 0 .. 255;

   subtype BYTE          is UNSIGNED_TINY_INTEGER;

   subtype ADDRESS_RANGE is INTEGER range 0 .. 2 ** 24 - 1;

   ADDRESS_NULL : constant ADDRESS;

   --These functions efficiently copy aligned elements of the specified size.
   --You can declare them locally using any scalar types with
   --PRAGMA interface(assembler,<Routine>);
   --WARNING: these routines work for scalar types only!!!!!!

   function  COPY_DOUBLEWORD (FROM : LONG_FLOAT) return LONG_FLOAT;
   pragma INTERFACE (ASSEMBLER, COPY_DOUBLEWORD);

   function  COPY_FULLWORD (FROM : INTEGER) return ADDRESS;
   function  COPY_FULLWORD (FROM : ADDRESS) return INTEGER;
   pragma INTERFACE (ASSEMBLER, COPY_FULLWORD);

   function  COPY_HALFWORD (FROM : SHORT_INTEGER) return SHORT_INTEGER;
   pragma INTERFACE (ASSEMBLER, COPY_HALFWORD);

   function  COPY_BYTE (FROM : TINY_INTEGER) return TINY_INTEGER;
   pragma INTERFACE (ASSEMBLER, COPY_BYTE);

   --Address conversion routines

   function  INTEGER_TO_ADDRESS (ADDR : ADDRESS_RANGE) return ADDRESS
      renames COPY_FULLWORD;

   function  ADDRESS_TO_INTEGER (ADDR : ADDRESS) return ADDRESS_RANGE
      renames COPY_FULLWORD;

   function  "+" (ADDR    : ADDRESS;
```

```
                    OFFSET : INTEGER) return ADDRESS;

   function  "-" (ADDR   : ADDRESS;
                  OFFSET : INTEGER) return ADDRESS;

   --This is a 32-bit type which is passed by value

   type EXCEPTION_ID is private;

   function  LAST_EXCEPTION_ID return EXCEPTION_ID;

private

   --Implementation defined

end SYSTEM;
```

## F.7 INTERFACE TO OTHER LANGUAGES

Pragma INTERFACE is implemented for two languages, ASSEMBLER and FORTRAN. The pragma can take one of three forms:

1. For any assembly language procedure or function:

```
pragma INTERFACE (ASSEMBLER, ROUTINE_NAME);
```

2. For FORTRAN functions with only in parameters or procedures:

```
pragma INTERFACE (FORTRAN, ROUTINE_NAME);
```

3. For FORTRAN functions that have in out or out parameters:

```
pragma INTERFACE (FORTRAN, ROUTINE_NAME, IS_FUNCTION);
```

In the C$^3$Ada system, functions cannot have in out or out parameters so the Ada specification for the function is written as a procedure with the first argument being the function return result. Then, the parameter IS_FUNCTION is specified to inform the compiler that it is, in reality, a FORTRAN function. Interface routine_names are truncated to an 8 character maximum length.

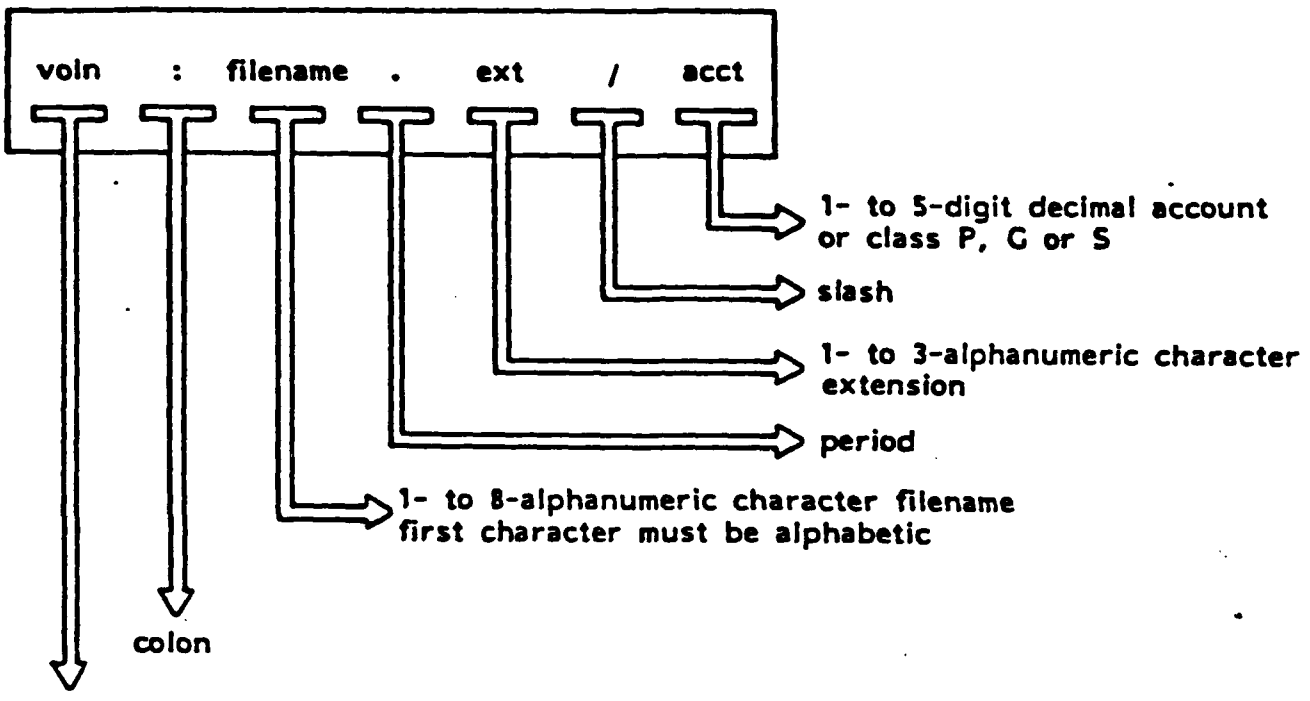
## F.8 INPUT/OUTPUT (I/O) PACKAGES

The following two system-dependent parameters are used for the control of external files:

- NAME parameter
- FORM parameter

The NAME parameter must be an OS/32 file name string. OS/32 filenames are specified as follows:

424-3




The implementation-dependent values used for keywords in the FORM parameter are discussed below. The FORM parameter is a string that contains further system-dependent characteristics and attributes of an external file. The FORM parameter is able to convey to the file system information on the intended use of the associated external file. This parameter is used as one of the specifications for the CREATE procedure and the OPEN procedure. It specifies a number of system-dependent characteristics such as lu, file format, etc. It is returned by the FORM function.

The syntax of the FORM string, in our implementation, uses Ada syntax conventions and is as follows:

```
form_param  ::= [form_spec {, form_spec}]
form_spec   ::= lu_spec | fo_spec |
                rs_spec | dbf_spec |
                ibf_spec | al_spec |
                pr_spec | keys_spec |
                pad_spec | dc_spec |
                da_spec | ds_spec |
                ps_spec | ch_spec
lu_spec     ::= LU => lu
fo_spec     ::= FILE_ORGANIZATION => fo
rs_spec     ::= RECORD_SIZE => rs
dbf_spec    ::= DATA_BLOCKING_FACTOR => dbf
ibf_spec    ::= INDEX_BLOCKING_FACTOR => ibf
al_spec     ::= ALLOCATION => al
pr_spec     ::= PRIVILEGE => pr
keys_spec   ::= KEYS => keys
pad_spec    ::= PAD => pad
dc_spec     ::= DEVICE_CODE => dc
da_spec     ::= DEVICE_ATTRIBUTE => da
ds_spec     ::= DEVICE_STATUS => ds
ps_spec     ::= PROMPTING_STRING => ps
ch_spec     ::= CHARACTER_IO
```

The exception USE_ERROR is raised if a given FORM parameter string does not have the correct syntax or if certain conditions concerning the OPEN or CREATE statements are not fulfilled. Keywords that are listed above in upper-case letters are also recognized by the compiler in lower-case.

*lu* an integer in the range 0..254 specifying the logical unit (lu) number.

*fo* specifies legal OS/32 file formats (file organization). They are:

INDEX | IN
CONTIGUOUS | CO
NON_BUFFERED | NB
EXTENDABLE_CONTIGUOUS | EXTENDABLE_CONTIGUOUS | EC
LONG_RECORD | LR
ITAM
DEVICE

*rs* an integer in the range 1..65535 specifying the physical record size.

1. For INDEX, ITAM (inter telecommunications access method) and NON_BUFFERED files, this specifies the physical record size.
2. The physical record size for CONTIGUOUS and EXTENDABLE_CONTIGUOUS files is determined by rounding the element size up to the nearest 256-byte boundary. For such files, *rs* is ignored.
3. The physical record size for LONG_RECORD files is specified by the data blocking factor multiplied by 256 and *rs* is ignored.
4. For a DEVICE the physical record size always equals the element size and *rs* is ignored.

*dbf* Data_blocking_factor. An integer in the range 0..255 (as set up at OS/32 system generation (sysgen) time) that specifies the number of contiguous disk sectors (256 bytes) in a data block. It applies only to INDEX, NON_BUFFERED, EXTENDABLE_CONTIGUOUS and LONG_RECORD files. For other file organizations (see *file_organization* above), it is ignored. A value of 0 causes the data blocking factor to be set to the current OS/32 default.

*ibf* Index_blocking_factor. An integer in the range 0..255 (as set up at OS/32 sysgen time) specifying the number of contiguous disk sectors (256 bytes) in an index block of an INDEX, NON_BUFFERED, EXTENDABLE_CONTIGUOUS or LONG_RECORD file. For other file organizations (see *file_organization* above), it is ignored.

*al* Allocation. An integer in the range 1..2,147,483,647. For CONTIGUOUS files, it specifies the number of 256 byte sectors. For ITAM files, it specifies the physical block size in bytes associated with the buffered terminal. For other file organizations, (see *file_organization* above), it is ignored.

*pr* Privileges. Specifies OS/32 access privileges, e.g., shared read-only (SRO), exclusive read-only (ERO), shared write-only (SWO), exclusive write-only (EWO), shared read/write (SRW), shared read/exclusive write (SREW), exclusive read/shared write (ERSW) and exclusive read/write (ERW).

*keys* READ/WRITE keys. A decimal or hexadecimal integer specifying the OS/32 READ/WRITE keys, which range from 16#0000# to 16#FFFF#(0..65535). The left two hexadecimal digits signify the write protection key and the right two hexadecimal digits signify the read protection key. For more information on protection keys, see the *OS/32 Multi-Terminal Monitor (MTM) Primer.*

*pad* Pad character. Specifies the padding character used for READ and WRITE operations; the pad character is either NONE, BLANK or NUL. The default is NONE.

**TABLE F-3. PAD CHARACTER OPTIONS**

| PAD CHARACTER | ACTION |
|---|---|
| NONE | Records are not padded. (Default.) |
| NUL | Records are padded with ASCII.NUL. |
| BLANK | Records are padded with blanks and OS/32 ASCII I/O operations are used. |

*dc* Device code. An integer in the range 0..255 specifying the OS/32 device code of the external file. See the *System Generation/32 (SYSGEN/32) Reference Manual* for a list of all devices and their respective codes.

*da* Device attributes. An integer in the range 0..65535 specifying the OS/32 device attributes of the external file. See the *OS/32 Supervisor Call (SVC) Reference Manual* (Chapter 7, the table entitled Description and Mask Values of the Device Attributes Field) for all devices and their respective attributes.

*ds* Device status. An integer in the range 0..65535 specifying the status of the external file. A status of 0 means that the access to the file terminated with no errors; otherwise a device error has occurred. For errors occurring during READ and WRITE operations, the status values and their meanings are found in Chapter 2 (The tables on Device-Independent and Device-Dependent Status Codes) of the *OS/32 Supervisor Call (SVC) Reference Manual.*

*ps* Prompting string. This quoted string is output on the terminal before the GET operation only if the file is associated with a terminal; otherwise this FORM parameter is ignored. The default is the null string, in which case no string is output to the terminal.

*character_io* If character_io is specified in the FORM string, the only other allowable FORM parameters are LU => *lu*, FILE_ORGANIZATION => DEVICE and PRIVILEGE=> SRW. Furthermore, the NAME string must denote a terminal or interactive device. In order for character_io to work properly, the user must specify ENABLE TYPEAHEAD to MTM, to turn on BIOC's type ahead feature.

### F.8.1 Text Input/Ouput (I/O)

There are two implementation-dependent types for TEXT_IO: COUNT and FIELD. Their declarations implemented for the C'Ada Compiler are as follows:

```
type COUNT is range 0 ..INTEGER'LAST;
subtype FIELD is INTEGER range 0 ..255;
```

### F.8.1.1 End of File Markers

When working with text files, the following representations are used for end of file markers. A line terminator followed by a page terminator is represented by:

```
ASCII.FF  ASCII.CR
```

A line terminator followed by a page terminator, which is then followed by a file terminator is represented by:

```
ASCII.FF ASCII.EOT ASCII.CR
```

End of file may also be represented as the physical end of file. For input from a terminal, the combination above is represented by the control characters:

```
ASCII.FF ASCII.EOT ASCII.CR
```

or with BIOC:

```
ASCII.DC4 ASCII.EOT ASCII.CR, i.e., ^T ^D <cr>
```

## F.8.2 Restrictions on ELEMENT_TYPE

The following are the restrictions concerning ELEMENT_TYPE:

1. I/O of access types is undefined, although allowable; i.e., the fundamental association between the access variable and its accessed type is ignored.
2. The maximum size of a variant data type is always used.
3. If the size of the element type is exceeded by the physical record length, then during a READ operation the extra data on the physical record is lost. The exception DATA_ERROR is not raised.
4. If the size of the element type exceeds the physical record length during a WRITE operation, the extra data in the element is not transferred to the external file and DATA_ERROR is not raised.
5. I/O operations or composite types containing dynamic array components will not transfer these components because they are not physically contained within the record itself.

## F.8.3 TEXT Input/Output (I/O) on a Terminal

A line terminator is detected when either an ASCII.CR is input or output, or when the operating system detects a full buffer. No spanned records with ASCII.NUL are output.

A line terminator followed by a page terminator may be represented as:

```
ASCII.CR
ASCII.FF ASCII.CR
```

if they are issued separately by the user, e.g., NEW_LINE followed by a NEW_PAGE. The same reasoning applies for a line terminator followed by a page terminator, which is then followed by a file terminator.

All text I/O operations are buffered, unless for CHARACTER_IO is specified. This means that physical I/O operations are performed on a line by line basis, as opposed to a character by character basis. For example:

```
put ("Enter Data");
get_line (data, len);
```

will not output the string "Enter Data" until the next put_line or new_line operation is performed.

## F.9 UNCHECKED PROGRAMMING

Unchecked programming gives the programmer the ability to circumvent some of the strong typing and elaboration rules of the Ada language. As such, it is the programmer's responsibility to ensure that the guidelines provided in the following sections are followed.

### F.9.1 Unchecked Storage Deallocation

The unchecked storage deallocation generic procedure explicitly deallocates the space for a dynamically acquired object.

**Restrictions:**

This procedure frees storage only if:

1. The object being deallocated was the last one allocated of all objects in a given declarative part.
2. All objects in a single chunk of the collection belonging to all access types declared in the same declarative part are deallocated.

### F.9.2 Unchecked Type Conversions

The unchecked type conversion generic function permits the user to convert, without type checking, from one type to another. It is the user's responsibility to guarantee that such a conversion preserves the properties of the target type.

**Restrictions:**

The object used as the parameter in the function may not have components which contain dynamic or unconstrained array types.

If the target'size is greater than the source'size, the resulting conversion is unpredictable. If the target'size is less than the source'size, the result is that the left-most bits of the source are placed in the target.

Since unchecked_conversion is implemented as an arbitrary block move, no alignment constraints are necessary on the source or the target operands.

## F.10 IMPLEMENTATION-DEPENDENT RESTRICTIONS

1. The main procedure must be parameterless.
2. The source line length must be less than or equal to 80 characters.
3. Due to the source line length, the largest identifier is 80 characters.
4. No more than 9998 lines in a single compilation unit.
5. The maximum number of library units is 9999.
6. The maximum number of bits in an object is $2^{31}-1$.
7. The maximum static nesting level is 63.
8. The maximum number of directly imported units of a single compilation unit must not exceed 255.
9. Recompilation of SYSTEM or CALENDAR specification is prohibited.
10. ENTRY'ADDRESS, PACKAGE'ADDRESS and LABEL'ADDRESS are not supported.
11. The maximum number of nested SEPARATES is 63.
12. The maximum length of a filename is 80 characters.
13. The maximum length of a program library name is 64 characters.
14. The maximum length of a listing line is 125 characters.
15. The maximum number of errors handled is 1000.
16. The maximum subprogram nesting level is 64.
17. The maximum number of calls to pragma ELABORATE is 255.
18. The maximum number of unique symbols (identifiers, characters, and strings) per compilation is 12503.

19. The total size for text of unique symbols per compilation is 100000.
20. The maximum parser stack depth is 1000.
21. The maximum depth of packages is 100.
22. The static aggregate nesting limit is 256.

## F.11 UNCONSTRAINED RECORD REPRESENTATIONS

Objects of an unconstrained record type with array components based on the discriminant are allocated using the discriminant value supplied in the object declaration. If the size of an unconstrained component has the potential of exceeding 2 Gb, the exception NUMERIC_ERROR is raised. Assignment of a default maximum discriminant value does not occur. For example:

```
type DYNAMIC_STRING( LENGTH : NATURAL := 10 )
     is record
     STR : STRING( 1 .. LENGTH );
     end record;
DSTR : DYNAMIC_STRING;
```

For this record, the compiler attempts to allocate NATURAL'LAST bytes for the record. Because this is greater than 2GB, the exception NUMERIC_ERROR is raised. However, the declaration

```
D : DYNAMIC_STRING(80);
```

raises no exception and creates a record containing an 80 byte string.

## F.12 TASKING IMPLEMENTATION

The C³Ada tasking implementation uses the co-routine paradigm. That is, a task never yields control of the processor until either:

- it is suspended at an accept statement,
- it is suspended at an entry call statement,
- it is suspended at a delay statement (with simple_expression > 0.0),
- an open delay alternative is selected,
- an open terminate alternative is selected,
- it has completed its execution,
- it activates another task,
- it aborts a task, or
- a master construct is suspended while dependent tasks terminate.

There is only one OS/32 task for all Ada tasks in this model.

Tasks that depend on library packages are aborted when the main program terminates.

## APPENDIX C

## TEST PARAMETERS

Certain tests in the ACVC make use of implementation-dependent values, such as the maximum length of an input line and invalid file names. A test that makes use of such values is identified by the extension .TST in its file name. Actual values to be substituted are represented by names that begin with a dollar sign. A value must be substituted for each of these names before the test is run. The values used for this validation are given below.

| Name and Meaning | Value |
|---|---|
| $BIG_ID1<br>Identifier the size of the maximum input line length with varying last character. | (1..79 => 'A', 80 => '1') |
| $BIG_ID2<br>Identifier the size of the maximum input line length with varying last character. | (1..79 => 'A', 80 => '2') |
| $BIG_ID3<br>Identifier the size of the maximum input line length with varying middle character. | (1..39 => 'A', 40 => '3', 41..80 => 'A') |
| $BIG_ID4<br>Identifier the size of the maximum input line length with varying middle character. | (1..39 => 'A', 40 => '4', 41..80 => 'A') |
| $BIG_INT_LIT<br>An integer literal of value 298 with enough leading zeroes so that it is the size of the maximum line length. | (1..77 => '0', 78..80 => "298") |

TEST PARAMETERS

| Name and Meaning | Value |
|---|---|
| $BIG_REAL_LIT<br>A universal real literal of value 690.0 with enough leading zeroes to be the size of the maximum line length. | (1..75 => '0', 76..80 => "690.0") |
| $BIG_STRING1<br>A string literal which when catenated with BIG_STRING2 yields the image of BIG_ID1. | (1..60 => 'A') |
| $BIG_STRING2<br>A string literal which when catenated to the end of BIG_STRING1 yields the image of BIG_ID1. | (1..19 => 'A', 20 => '1') |
| $BLANKS<br>A sequence of blanks twenty characters less than the size of the maximum line length. | (1..60 => ' ') |
| $COUNT_LAST<br>A universal integer literal whose value is TEXT_IO.COUNT'LAST. | 2_147_483_647 |
| $FIELD_LAST<br>A universal integer literal whose value is TEXT_IO.FIELD'LAST. | 255 |
| $FILE_NAME_WITH_BAD_CHARS<br>An external file name that either contains invalid characters or is too long. | F_#$.BAD |
| $FILE_NAME_WITH_WILD_CARD_CHAR<br>An external file name that either contains a wild card character or is too long. | FILENAME2.BAD |
| $GREATER_THAN_DURATION<br>A universal real literal that lies between DURATION'BASE'LAST and DURATION'LAST or any value in the range of DURATION. | 100_000.0 |

| Name and Meaning | Value |
|---|---|
| $GREATER_THAN_DURATION_BASE_LAST<br>A universal real literal that is greater than DURATION'BASE'LAST. | 4_294_967_295.0 |
| $ILLEGAL_EXTERNAL_FILE_NAME1<br>An external file name which contains invalid characters. | ILLEGAL_.FIL |
| $ILLEGAL_EXTERNAL_FILE_NAME2<br>An external file name which is too long. | ILLEGALFILE.NAM |
| $INTEGER_FIRST<br>A universal integer literal whose value is INTEGER'FIRST. | -2147483648 |
| $INTEGER_LAST<br>A universal integer literal whose value is INTEGER'LAST. | 2147483647 |
| $INTEGER_LAST_PLUS_1<br>A universal integer literal whose value is INTEGER'LAST + 1. | 2_147_483_648 |
| $LESS_THAN_DURATION<br>A universal real literal that lies between DURATION'BASE'FIRST and DURATION'FIRST or any value in the range of DURATION. | -100_000.0 |
| $LESS_THAN_DURATION_BASE_FIRST<br>A universal real literal that is less than DURATION'BASE'FIRST. | -4_294_967_296.0 |
| $MAX_DIGITS<br>Maximum digits supported for floating-point types. | 15 |
| $MAX_IN_LEN<br>Maximum input line length permitted by the implementation. | 80 |
| $MAX_INT<br>A universal integer literal whose value is SYSTEM.MAX_INT. | 2147483647 |
| $MAX_INT_PLUS_1<br>A universal integer literal whose value is SYSTEM.MAX_INT+1. | 2_147_483_648 |

TEST PARAMETERS

| Name and Meaning | Value |
|---|---|
| $MAX_LEN_INT_BASED_LITERAL<br>A universal integer based literal whose value is 2#11# with enough leading zeroes in the mantissa to be MAX_IN_LEN long. | (1..2 => "2:", 3..77 => '0',<br>78..80 => "11:") |
| $MAX_LEN_REAL_BASED_LITERAL<br>A universal real based literal whose value is 16:F.E: with enough leading zeroes in the mantissa to be MAX_IN_LEN long. | (1..3 => "16:", 4..76 => '0',<br>77..80 => "F.E:") |
| $MAX_STRING_LITERAL<br>A string literal of size MAX_IN_LEN, including the quote characters. | (1 => '"', 2..79 => 'A', 80 => '"') |
| $MIN_INT<br>A universal integer literal whose value is SYSTEM.MIN_INT. | -2147483648 |
| $NAME<br>A name of a predefined numeric type other than FLOAT, INTEGER, SHORT_FLOAT, SHORT_INTEGER, LONG_FLOAT, or LONG_INTEGER. | TINY_INTEGER |
| $NEG_BASED_INT<br>A based integer literal whose highest order nonzero bit falls in the sign bit position of the representation for SYSTEM.MAX_INT. | 16#FFFFFFFE# |

## APPENDIX D

## WITHDRAWN TESTS

Some tests are withdrawn from the ACVC because they do not conform to the Ada Standard. The following 27 tests had been withdrawn at the time of validation testing for the reasons indicated. A reference of the form "AI-ddddd" is to an Ada Commentary.

- B28003A: A basic declaration (line 36) incorrectly follows a later declaration.
- E28005C: This test requires that "PRAGMA LIST (ON);" not appear in a listing that has been suspended by a previous "PRAGMA LIST (OFF);"; the Ada Standard is not clear on this point, and the matter will be reviewed by the AJPO.
- C34004A: The expression in line 168 yields a value outside the range of the target type T, but there is no handler for CONSTRAINT_ERROR.
- C35502P: The equality operators in lines 62 and 69 should be inequality operators.
- A35902C: The assignment in line 17 of the nominal upper bound of a fixed-point type to an object raises CONSTRAINT_ERROR, for that value lies outside of the actual range of the type.
- C35904A: The elaboration of the fixed-point subtype on line 28 wrongly raises CONSTRAINT_ERROR, because its upper bound exceeds that of the type.
- C35904B: The subtype declaration that is expected to raise CONSTRAINT_ERROR when its compatibility is checked against that of various types passed as actual generic parameters, may, in fact, raise NUMERIC_ERROR or CONSTRAINT_ERROR for reasons not anticipated by the test.

WITHDRAWN TESTS

- C35A03E and C35A03R: These tests assume that attribute 'MANTISSA returns 0 when applied to a fixed-point type with a null range, but the Ada Standard does not support this assumption.

- C37213H: The subtype declaration of SCONS in line 100 is incorrectly expected to raise an exception when elaborated.

- C37213J: The aggregate in line 451 incorrectly raises CONSTRAINT_ERROR.

- C37215C, C37215E, C37215G, and C37215H: Various discriminant constraints are incorrectly expected to be incompatible with type CONS.

- C38102C: The fixed-point conversion on line 23 wrongly raises CONSTRAINT_ERROR.

- C41402A: The attribute 'STORAGE_SIZE is incorrectly applied to an object of an access type.

- C45332A: The test expects that either an expression in line 52 will raise an exception or else MACHINE_OVERFLOWS is FALSE. However, an implementation may evaluate the expression correctly using a type with a wider range than the base type of the operands, and MACHINE_OVERFLOWS may still be TRUE.

- C45614C: The function call of IDENT_INT in line 15 uses an argument of the wrong type.

- A74106C, C85018B, C87B04B, and CC1311B: A bound specified in a fixed-point subtype declaration lies outside of that calculated for the base type, raising CONSTRAINT_ERROR. Errors of this sort occur at lines 37 & 59, 142 & 143, 16 & 48, and 252 & 253 of the four tests, respectively.

- BC3105A: Lines 159 through 168 expect error messages, but these lines are correct Ada.

- AD1A01A: The declaration of subtype SINT3 raises CONSTRAINT_ERROR for implementations which select INT'SIZE to be 16 or greater.

- CE2401H: The record aggregates in lines 105 and 117 contain the wrong values.

- CE3208A: This test expects that an attempt to open the default output file (after it was closed) with mode IN_FILE raises NAME_ERROR or USE_ERROR; by Commentary AI-00048, MODE_ERROR should be raised.

END

DATE

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3-89

DTIC

# SUPPLEMENTARY

# INFORMATION

ERRATA DTIC# A204 448

AD-A204 448

Ada Compiler Validation Summary Report:

Compiler Name: C$^3$Ada, R02-00.00

Certificate Number: 880627W1.09093

| Host: | Target: |
|---|---|
| Concurrent Computer Corporation<br>3280 MPS under OS/32,<br>Version R08-02.02 | Concurrent Computer Corporation<br>3280 MPS under OS/32,<br>Version R08-02.02 |

Testing Completed 30 June 1988 Using ACVC 1.9

This report has been reviewed and is approved.

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